ASSAM UNIVERSITY, SILCHAR

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

PG PROGRAMME COURSE STRUCTURE & SYLLABUS

Chapter-1

General, Course structure & Theme

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Semester-wise credit distribution

A. Definition of Credit:

A. definition of Credit:	
1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
2 Hours Practical/ Lab (L) per week	1 Credit

B. Distinct features of model PG curriculum in Computer Science & Engineering prescribed by AICTE and adopted by CSE Department, Assam University, Silchar

1. Standardized academic structure for all PG Programs with uniform credit distribution.
2. Advanced study of specialization through core subjects, flexible and diverse program specific electives.
3. Open electives to widen skills.
4. Enhanced engagement of industry in developing innovations and problem solutions.
5. Collaborating and interactive learning to ensure talent development.
6. Inbuilt mechanism for regular upgradation of curriculum.
7. Focus on development of advanced knowledge and specific skills required for industrial development.
8. Ensured competency development of learner

C. Curriculum structure: Total credits (2 year course): 68

Semester-I (First Year) Curriculum

Course Number	**Type of Course**	**Course Code**	**Course Title**	Scheme Of Studies Per Week			**Credits**
				L	**T**	**P**	
1.	Professional Core Courses	MCSE 101	Mathematical foundations of Computer Science	3	0	0	3
2.	Professional Core Courses	MCSE 102	Advanced Data Structures	3	0	0	3
3.	Professional Core Courses	MCSE 103	Soft Computing	3	0	0	3
4.	Professional Elective Courses	MCSE 104 A/B/C/D/E	Elective-I	3	0	0	3
5.	Mandatory Course	MCSE 105	Research Methodology and IPR	2	0	0	2
6.	Audit Course	MCSE 106A/B/C/ D/E/F/G/H	Audit Course	2	0	0	0
7.	Professional Core Courses	MCSE 107	Advanced Data Structures Lab	0	0	4	2
8.	Professional Core Courses	MCSE 108	Soft Computing Lab	0	0	4	2
				Total Credits			**18**

Semester-II (First Year) Curriculum

Course Number	**Type of Course**	**Course Code**	**Course Title**	Scheme Of Studies Per Week			**Credits**
				L	**T**	**P**	
1.	Professional Core Courses	MCSE 201	Advance Algorithms	3	0	0	3
2.	Professional Core Courses	MCSE 202	Advanced Computer Networks	3	0	0	3
3.	Professional Elective Courses	MCSE 203A/B/ C/D/E	Elective-II	3	0	0	3
4.	Professional Elective Courses	MCSE 204A/B/ C/D/E	Elective-III	3	0	0	3
5.	Audit Course	MCSE 205A/B/C/D/ E/F/G/H	Audit Course	2	0	0	0
6.	Professional Core Courses	MCSE 206	Advanced Algorithms Lab	0	0	4	2
7.	Professional Core Courses	MCSE 207	Advanced Computer Networks Lab	0	0	4	2
8.	Project	MCSE 208	Mini Project With Seminar	0	0	4	2
				Total Credits			**18**

Semester-III (Second Year) Curriculum

Course Number	Type of Course	Course Code	Course Title	Scheme Of Studies Per Week			Credits
				L	**T**	**P**	
1.	Professional Elective Courses	MCSE 301A/B/ C/D/E	Elective-IV	3	0	0	3
2.	Open Elective Courses	To be provided by offering Department		3	0	0	3
3.	Dissertation/ Industrial Project	MCSE 302	Dissertation/ Industrial Project	0	0	20	10
				Total Credits			**16**

Semester-IV (Second Year) Curriculum

Course Number	Type of Course	Course Code	Course Title	Scheme Of Studies Per Week			Credits
				L	**T**	**P**	
1.	Dissertation	MCSE 401	Dissertation- II	0	0	32	16
				Total Credits			**16**

LIST OF ELECTIVE PAPERS FOR THE STUDENTS OF CSE

Domain	Elective I	Elective II	Elective III	Elective IV
S-1	A. Advanced Operating Systems	A. Advanced DBMS	A. Advanced Computer Architecture	A. Formal Methods for System Verifications
S-2	B. Natural Language Processing	B. Pattern Recognition	B. Information Storage and Retrieval	B. Speech Processing
S-3	C. Advanced Statistical Methods	C. Image Processing	C. Machine Learning	C. Deep Learning
S-4	D. Wireless and Sensor Networks	D. Cryptography and Network Security	D. Network on Chip	D. Internet of Things
S-5	E. Data Mining and Data Warehousing	E. Data Science	E. Cloud Computing	E. Social Network Analytics

LIST OF OPEN ELECTIVES TO BE OFFERED BY THE DEPARTMENT FOR OTHER DEPARTMENTS' STUDENTS:

MCSE303 A. Soft Computing Techniques

MCSE303B. Mobile Technology

MCSE303C. Basic Programming Concepts

MCSE303D. Software Engineering Paradigms

MCSE303E. Web and Internet Technology

MCSE303F. Matlab

MCSE303G. Introduction to Cryptography

LIST OF AUDIT COURSES

A. English for Research Paper Writing

B. Disaster Management

C. Sanskrit for Technical Knowledge

D. Value Education

E. Constitution of India

F. Pedagogy Studies

G. Stress Management by Yoga

H. Personality Development through Life Enlightenment Skills.

Chapter-2
Detail Syllabus

Mathematical Foundations of Computer Science

Course Code	MCSE 101
Course Name	Mathematical Foundations of Computer Science
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Discrete Mathematics

COURSE OBJECTIVES

- Students should be able to understand the mathematical logic that is prerequisites for a variety of courses like Data mining, Computer Networks, analysis of Web traffic, Cryptography, System modeling, Distributed systems, Machine learning, Image processing.
- Students should be able to develop a mathematical and logical basis to many modern techniques in the field of information technology like programming language design, Queuing Theory, Network security, IoT, etc.
- Students learn about the construction of mathematical modeling in a given problem relates to the field of Computer Science and Engineering.

Syllabus

UNIT I	Hours = 40
Review of sets, functions, relations; Logic: formulae, interpretations, methods of proof in propositional and predicate logic; Boolean logic; Mathematical reasoning and proofs: theorems and types of proofs, deductive, inductive, by construction, contradiction and counter examples.	10
UNIT II	
Probability: conditional probability, random variables, probability distributions, Expected value, variance, conditional expectation, tail inequalities, Markov chains; Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood; Basics of Counting, permutations, combinations, partitions, recurrences, generating functions, Repetitions, Binomial Coefficients	10
UNIT III	
Algorithms, the growth of functions, complexity of algorithms, the integers and division; Number theory: division algorithm, Euclid's algorithm, fundamental theorem of arithmetic, Chinese remainder theorem; Matrices.	6
UNIT IV	

Properties of Graphs, isomorphism, complete graphs, bipartite graphs, matching, colourability, planarity, trees and fundamental circuits, hamiltonian and Euler circuits, cut-set and cut-vertices.	7
UNIT V	
Modeling Computation: languages and Grammars, Finite-State Machines with Output, Finite-State Machines with No Output, Languages recognition, Turing Machines.	7

Text Books:

1. Elements of Discrete Mathematics, 4th Edition, C L Liu and D. P. Mohapatra, series: Indian Higher Education Computer Science & Engineering, published: 27-Jul-2012.
2. Discrete Mathematics and its Applications with Combinatorics and Graph Theory, 7th Edition, Kenneth Rosen, Indian Adaptation by Kamala Krithivasan, published by McGraw Hill, Copyright © 20011, 2007.
3. Probability and Statistics with Reliability, Queuing and Computer Science Applications, 2nd Edition, Kishor S. Trivedi, published by Willey, Copyright © 2016 by John Wiley & Sons.

Reference books:

1. Discrete Structures, Logic, and Computability, 3rd Edition, James L. Hein, published by Jones and Bartl, Copyright © 2010 by Jones and Bartl Publishers LLC.
2. Introduction to Automata Theory, Languages and Computations, 3rd Edition, J.E. Hopcroft, Rajeev Motwani & J. D. Ullman, published by Pearson, Copyright © 2008 Dorling Kindersley (India) Pvt. Ltd.
3. Graph Theory with applications to engineering and computer science, Narsingh Deo, published by PHI.

COURSE OUTCOMES

- Students will be able to apply the concept of set, relation, function in the different field of computer science.
- Students will be able to analysis the correctness of algorithms in a given problem.
- To understand the methods of statistical inference, and the role that sampling distributions play in those methods.
- Students will be able to understand the analysis of algorithms, the growth of functions, basic properties of graphs and their different applications.
- Students also gain knowledge of modeling of computation.

Advanced Data Structures

Course Code	MCSE 102
Course Name	Advanced Data Structures
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	UG level course in Data Structures

COURSE OBJECTIVES:

- The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
- Students should be able to understand the necessary mathematical abstraction to solve problems.
- To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
- Student should be able to come up with analysis of efficiency and proofs of correctness.

Syllabus

UNIT I	Hours=40
Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. **Hashing:** Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.	8
UNIT II	
Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists	6
UNIT III	
Trees: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees	9
UNIT IV	
Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.	10
UNIT V	
Computational Geometry: One Dimensional Range Searching, Two Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees.	7

Suggested Readings:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

COURSE OUTCOMES

After completion of course, students would be able to:

- Understand the implementation of symbol table using hashing techniques.
- Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
- Develop algorithms for text processing applications.
- Identify suitable data structures and develop algorithms for computational geometry problems.

Soft Computing

Course Code	MCSE 103
Course Name	Soft Computing
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	NIL

COURSE OBJECTIVES:

- To introduce concept of soft computing techniques and applications.
- To introduce basics of genetic algorithms and their applications in optimization problem
- To introduce the concepts of fuzzy sets, fuzzy logic and its application;
- To familiarize with tools and techniques of Soft Computing;
- To develop skills for solving problems in different application domain using Soft Computing Techniques.

UNIT – I	**Hours=40**
Introduction to Soft Computing and Neural Networks: Evolution of Computing: Soft Computing Constituents, Hard Computing, From Conventional AI to Computational Intelligence: Machine Learning Basics , Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning ,Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks	**10**
UNIT – II	
Fuzzy Logic: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership, Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.	**8**
UNIT – III	
GA and PSO: Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning: Machine Learning Approach to Knowledge Acquisition. Comparisons with Particle Swarm Optimization algorithm. Single and multi-/many objective optimizations.	**7**
UNIT – IV	
Matlab/Python Library: Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic.	**8**
UNIT – V	
Recent Trends in machine learning, various classifiers, neural networks	7

and genetic algorithm, Implementation of recently proposed soft computing techniques.	

Text Books:

1. Neuro-Fuzzy and Soft computing: A Computational Approach to Learning and Machine Intelligence-Jang, Sun, Mizutani, Pearson Education (2004)
2. Principles of Soft Computing – S.N. Sivanandam and S. N. Deepa, Wiley India Pvt Limited (2011)

Reference Books:

1. Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications – S. Rajasekaran and G.A Vijayalakshmipai, Prentice-Hall of India Pvt Limited (2006)
2. Fuzzy Set Theory: Foundations and Applications- George J. Klir, Ute St. Clair, Bo Yuan, Prentice Hall(1997).
3. Neural Networks: Algorithms, Applications and Programming Techniques- Freeman J.A. & D.M.

COURSE OUTCOMES:

- Understanding of the basic areas of Soft Computing including Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms.
- Apply Genetic Algorithm to solve single objective and multi-objective optimization problems
- Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
- Apply neural networks to pattern classification and regression problems
- Effectively use existing software tools to solve real problems using a soft computing approach
- Develop some familiarity with current research problems and research methods in Soft Computing Techniques

Elective I

Course Code	MCSE 104 A/B/C/D/E
Course Name	As per the choice
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	
	Should be chosen from list of Electives

Research Methodology and IPR

Course Code	MCSE 105
Course Name	Research Methodology and IPR
Credits	2L:0T: 0 P (2 Credits)
Pre-Requisites	NIL

COURSE OBJECTIVES:

1. To identify and discuss the role and importance of research.
2. To identify and discuss the issues and concepts salient to the research process.
3. To identify and discuss the issues of technical writing.
4. To identify and discuss the IPR and patent issues.

Unit 1	Hours=30
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	6
Unit 2	
Effective literature studies approaches, Analysis, Plagiarism, Research ethics	5
Unit 3	
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	5
Unit 4	
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	5
Unit 5	
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	4
Unit 6	
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	5

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd , 2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand.

COURSE OUTCOMES:

At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Audit Course

Course Code	MCSE 105A/B/C/D/E/F/G/H
Course Name	As per the choice
Credits	0
Pre-Requisites	NIL
Comments	Should be chosen from list of Audit Courses

Advanced Data Structures Lab

Course Code	MCSE 106
Course Name	Advanced Data Structures Lab
Credits	0L:0T: 4 P (2 Credits)
Pre-Requisites	UG Course on Data Structures and Algorithms

COURSE OBJECTIVES

- To facilitate the graduates with the ability to visualize, gather information, articulate, analyze, solve complex problems, and make decisions.
- To facilitate the graduates with the technical skills that prepare them for immediate employment and pursue certification providing a deeper understanding of the technology in advanced areas of computer science and related fields

Sample Experiments

UNIT I

i. WAP to implement Stack ADT using Linked list with the basic operations as Create(), Is Empty(), Push(), Pop(), IsFull() with appropriate prototype to a functions.
ii. WAP to implement Queue ADT using Linked list with the basic functions of Create(), IsEmpty(), Insert(), Delete() and IsFull() with suitable prototype to a functions
iii. WAP to implement dynamic array and BST including traversal using recursion

UNIT II

WAP to implement following Sort on 1D array :

i. Quick Sort
ii. Merge Sort
iii. Bucket Sort
iv. Radix Sort
v. Bubble Sort
vi. Insertion Sort
vii. Selection Sort
viii. Heap Sort

UNIT III

WAP to store k keys into an array of size n at the location computed using a hash function, loc = key % n, where k<=n and k takes values from [1 to m], m>n. To handle the collisions use the following collision resolution techniques,

a. Linear probing
b. Quadratic probing
c. Random probing

d. Double hashing/rehashing

e. Chaining

i. Implement the above program I using hash function from Division methods.
ii. Implement the above program I using hash function from Truncation methods.
iii. Implement the above program I using hash function from Folding methods.
iv. Implement the above program I using hash function from Digit analysis methods.

UNIT IV

i. WAP using function which computes the balance factor of any given node in a BST.
ii. WAP to transform BST into AVL trees and also count the number rotations performed.
iii. WAP to implement Red-Black trees with insertion and deletion operation for the given input data as Strings
iv. WAP to implement insertion, deletion, display and search operation in m-way B tree

UNIT V

i. WAP to generate minimum spanning tree in a connected, undirected weighted graph using Kuruskal's algorithm with disjoint set data structures.
ii. WAP to generate minimum spanning tree in a connected, undirected weighted graph using Prims's algorithm with disjoint set data structures.
iii. WAP to implement Dijkstra's algorithm for single-source shortest path in a weighted directed graph
iv. WAP to find single-source shortest path in a weighted directed graph using Bellman- Ford algorithm
v. WAP to find all-pairs shortest path using Floyd-Warshall algorithm.

COURSE OUTCOMES

- Demonstrate knowledge and understanding of the problem and the nature of solution
- Gain hands-on experience and apply the principles of data structures
- Apply reasoning informed by the appropriate knowledge to assess different problem
- Able to identify the appropriate data structure for given problem.
- Graduate able to design and analyze the time and space complexity of algorithm or program.
- Ability to effectively use compilers includes library functions, debuggers and trouble shooting.

Soft Computing Lab

Course Code	MCSE 107
Course Name	Soft Computing Lab
Credits	0L:0T: 4 P (2 Credits)
Pre-Requisites	Basic C/C++ programming knowledge

COURSE OBJECTIVES

- Introduce students to basic idea of soft computing techniques which are useful for solving the non-linear and complex function
- familiarize students to use soft computing tools and techniques for designing and implementing soft computing based solutions for real world problems

Sample List of Experiments:

1. Problems based on GA and its applications.
2. Problems based on Fuzzy logic and its applications.
3. Problems based on ANN.
4. Problems based on hybrid systems and its application.

COURSE OUTCOMES

After completion of this course students will be able to

- Apply various soft computing approaches for solving problem
- Effectively use existing software tools to solve problems using a soft computing approach
- Evaluate and compare solutions by various soft computing approaches for a given problem

Advanced Algorithms

Course Code	MCSE 201
Course Name	Advanced Algorithms
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	UG level course in Algorithm Design and Analysis

COURSE OBJECTIVES

- Introduce students to the advanced methods of designing and analysis of algorithms in computing.
- Students should be able to select appropriate algorithm techniques for a specific problem.
- Students learn about the different modeling of problem-solving like data structures, graph, decomposing the problem, which is used to solve the advanced algorithmic issues.
- Students should be able to classify the different classes of problems based on their computational difficulties.

Syllabus

UNIT I	Hours = 40
Overview of Design Paradigms: *Background:* Motivation, the role of algorithms in computing, Analyzing of algorithms, algorithms like heap sort, search algorithms, etc. *Designing* *Techniques: over*view of Divide and Conquer, Greedy method, Dynamic Programming, Branch and Bound, Backtracking, Graph traversal algorithms.	7
UNIT II	
Matroids, String and Graph Matching: *Matroids:* Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST. *String Matching:* Introduction to string-matching problem, Naïve algorithm, Rabin Karp, String matching with finite automata, Knuth-Morris-Pratt algorithms and complexity analysis. *Graph Matching:* Algorithm to compute maximum matching. Characterization of maximum matching byaugmenting paths, Edmond's Blossom algorithm to compute augmenting path.	8
UNIT III	
Max-Flow Problem and Matrix Computation: *Flow-Networks:* Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm. *Matrix Computations:* Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.	8
UNIT IV	

Shortest Path Problems, Modulo Representation of integers/polynomials, Discrete Fourier Transform (DFT): *Shortest Path Problems in Graphs:* Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming. *Modulo Representation of integers/polynomials:* Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. *Discrete Fourier Transform:* DFT and FFTalgorithms.	8
UNIT V	
Theory of NP-Hard and NP-Completeness Problems, and Approximation Algorithms: *Theory of NP-Hard and NP-Completeness Problems:* P, NP, and NPComplete complexity classes, Polynomial-time verification, NPcompleteness and reducibility, NP-completeness proofs. *Approximation Algorithms:* Notion of NP-completeness: P class, NP-hard class, NPcomplete class, Circuit Satisfiability problem, Clique Decision Problem, etc. *Approximation Algorithms: Approximation algorithms for vertex cover problem, set cover, TSP, knapsack, subset-sum problem etc.*	9

Text Books:

1. Introduction to Algorithms, 3rd Edition, T H. Cormen, C E. Leiserson, R L. Rivest, and Clifford Stein, published by PHI Learning Private Limited (Original edition published by the MIT Press, Cambridge, MA, USA), Copyright © 2011.
2. The Design and Analysis of Computer Algorithms by Aho, Hopcroft, Ullma.

Reference books:

1. Algorithm Design, 1st Edition, Jon Kleinberg, and Eva Tardos, published by Pearson Education Limited, Copyright © 2014.
2. Algorithms, 1st Edition, S. Dasgupta, C. Papadimitriou, and U. Vazirani, published by McGraw-Hill Education, Copyright © 2008.

COURSE OUTCOMES

- Students will be able to apply the concept and design strategies to algorithm design. Also, capable of writing the correctness of algorithms systematically.
- Students will be able to choose a suitable data structure for solving the problems, and also design the appropriate algorithms.
- Students will be capable of classifying the different class of problems based on their completeness theorem.
- Students will be able to understand more details in the field of advanced data structures for synthesizing more complicated problems in the field of engineering.

Advanced Computer Networks

Course Code	MCSE 202
Course Name	Advanced Computer Networks
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Computer Networks UG Level

COURSE OBJECTIVES

- To understand the state of the art in network protocols, network architecture, and networked systems.
- Students will be able to analyze different routing protocols and traffic engineering methods deployed in networking.
- To understand the concepts and applications of various wireless networks
- To familiarize with Overlay networks and Delay Tolerant Networks
- Understand the concept of SDN and its uses
- To engage ourselves in networking research

UNIT I	Hours = 40
Basic networking concepts: introduction to networks and layered architecture, data link layer, network layer, routing, end-to-end layer, congestion control, Network Traffic Modeling, simulation issues, network coding techniques	9
UNIT II	
Wireless Networks fundamentals, MIV4,MIPV6 , Micromobility Protocols, TCP performance in Wireless Networks, WIMAX, ZIGBEE.	7
UNIT III	
Overlay networks: Resilient Overlay Network, P2P, CDN, Web caching, cross-layer optimizations, Emerging network types: data center, Delay Tolerant Network(DTN), DTN Routing Protocols, DTN Applications	10
UNIT IV	
Software Defined Networks (SDNs): Fundamental Characteristics of SDN, SDN Operation, SDN Devices, SDN Applications, SDN Frameworks, SDN in the Data Center, Network Function Virtualization	8
UNIT V	
Multimedia Networks: Voice/Video over IP, IP Telephony, Voice over ATM, AAL2, Network management, Optical Networks	6

Text Books:

1. J.F. Kurose and K.W. Ross, Computer networking: A top-down approach, 6th edition
2. L.L. Peterson and BS. Davie, Computer Networks ISE: A System Approach, 5th edition, Morgan Kaufman.

Reference books:

1. SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies, By Thomas D. Nadeau, Ken Gray Publisher: O'Reilly Media, August 2013
2. Communication Network by Alberto Leon Garcia and IndraWidjaja
3. Software Defined Networks: A Comprehensive Approach, by Paul Goransson and Chuck Black, Morgan Kaufmann, June 2014

COURSE OUTCOMES

- Apply the concept learnt in this course to optimize and troubleshoot different networks
- Design and configure network for supporting a specified set of applications.

Elective II

Course Code	MCSE 203A/B/C/D/E
Course Name	As per the choice
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	
	Should be chosen form list of electives

Elective III

Course Code	MCSE 204 A/B/C/D/E
Course Name	As per the choice
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	
	Should be chosen from list of electives

Audit Course

Course Code	MCSE 205 A/B/C/D/E/F/G/H
Course Name	As per the choice
Credits	0
Pre-Requisites	NIL

Advanced Algorithms Lab

Course Code	MCSE 206
Course Name	Advanced Algorithms Lab
Credits	0L:0T: 4 P (2 Credits)
Pre-Requisites	Programming Language Skill

COURSE OBJECTIVES

- Students should be able to learn various algorithm designing techniques using the primary data structure. After designing the algorithms, its analysis the time and space complexity, and implement to any standard programming language like C/C++/Java/Python.
- Principles for good algorithm design and verified by the implementation, especially the uses of data abstraction.

Sample Problems:

1. Write an algorithm (Iterative/ Euclid) for greatest common divisor (GCD) in the given two numbers. Now, implement these algorithms based on time complexity, and justify which algorithms is better in terms of time complexity.
2. Implement the Quicksort and Merge sort. Analysis the time complexity. Observed based on your implementation, why divide-and-conquer technique is used here.
3. Give an infinite array in which the first n cells contain integers in sorted order, and rest of the cells are filled with some special symbol (say $). Assume, we do not know the n value. Give an algorithm and implement that takes an integer k as input and find the position in the array containing k, if such position exists, in O(logn) time.
4. Given a sorted array of non-repeated/distinct integers A[1…..n]. Write an algorithm such that there is an index I for which a[i]=i in O(logn) time. Implement your algorithm to justify your runtime.
5. Implement the Tower of Hanoi problem for n number of discs, and analysis the time complexity.
6. Implement the closest-Pair of points (Assume that all points are one dimensional) and analysis the time complexity.
7. Implement the maximum value of contiguous subsequences and analysis the time complexity.
8. Implement the Topological sort and analysis the time complexity.
9. Implement the Huffman coding compression algorithms.
10. Implement the Prim’s and Krushkal’s algorithms.
11. Implement shortest path in weighted Graph (Dijkstra’s algorithm).
12. Implement the coin change problem.
13. Implement the fractional knapsack problem
14. Implement the job scheduling algorithm.
15. Implement the matrix chain Multiplication.
16. Implement the Traveling Salesman problem.

Reference books:

1. Data Structures and Algorithms in java, 3rd edition, A.Drozdek, Cengage Learning.
2. Data Structures with Java, J.R.Hubbard, 2ndedition, Schaum's Outlines, TMH.
3. Design and Analysis of Algorithms, P.H.Dave and H.B.Dave, Pearson education.
4. Data Structures and java collections frame work, W.J.Collins, Mc Graw Hill.
5. Problem Solving with Algorithms and Data Structures using Python, by Brad Miller and David Ranum, Luther College.
6. Data Structures and Algorithms in Python by Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Wiley.

COURSE OUTCOMES

Students will be able to

- design the problem in algorithm way and validate the algorithm through implementation.
- detail the analysis of all the algorithm design techniques through implementation.
- understand the proper data structure is used based on the given problem.

Advanced Computer Networks Lab

Course Code	MCSE 207
Course Name	Advanced Computer Networks Lab
Credits	0L:0T: 4 P (2 Credits)
Pre-Requisites	Computer Networks

COURSE OBJECTIVES

- To understand basic socket functions for both TCP and UDP
- To familiarize with SCTP, I/O multiplexing, socket options, and basic name and address conversions
- To understand how IPC works

Sample Problems:

1. Introduction to socket programming
2. TCP & UDP client server Programming
3. I/O Multiplexing and socket options
4. Concurrent Processing in Client-Server
5. Software-Byte ordering and address conversion functions
6. Socket Interface
7. System calls used with sockets
8. Iterative server and concurrent server
9. Thread Creation and Termination
10. TCP Echo Server using threads
11. IPC
12. Remote Procedure Call

Text Books:

1. Richards Stevens, Unix network programming, , Vol I, 3rd edition, Prentice Hall, 2010
2. Richards Stevens, Unix network programming, , Vol II, 3rd edition, Prentice Hall, 2010

COURSE OUTCOMES

- Design and Develop the TCP based client server programs. •
- Design and Develop the UDP based client server programs. •
- Implement the concurrent and iterative servers
- For a given problem related TCP/IP protocol develop the network programming
- Students will be able to implement IPC

Elective IV

Course Code	MCSE 301 A/B/C/D/E
Course Name	As per the choice
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	
	Should be chosen from list of electives

Open Elective I

Course Code	As per the choice of department and paper
Course Name	As per the choice
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	
	To be Provided by other Departments

Audit Course 1 & 2

A. English for Research Paper Writing

Course Code	MCSE 106/205 A
Course Name	English for Research Paper Writing
Credits	0
Pre-Requisites	NIL

COURSE OBJECTIVES:

Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title

Syllabus

Unit I	Hours=24
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing, Redundancy, Avoiding Ambiguity and Vagueness, Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism.	5
Unit II	
Sections of a Paper, Abstracts. Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	5
Unit III	
key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.	5
Unit IV	
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, and skills are needed when writing the Conclusions.	5
Unit V	
Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.	4

Suggested Studies:

1. R. Goldbort ,Writing for Science, Yale University Press (available on Google Books), (2006).
2. R. Day, How to Write and Publish a Scientific Paper, Cambridge University Press, (2006).
3. N. Highman Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook, (1998).
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

COURSE OUTCOMES:

Students will be able to:
1. Plan and prepare outlines for research papers
2. select source material for research papers
3. take and organize good notes for research
4. use appropriate academic terms and language for research papers
5. avoid plagiarizing your sources

B. Disaster Management

Course Code	MCSE 106/205 B
Course Name	Disaster Management
Credits	0
Pre-Requisites	NIL

COURSE OBJECTIVES:
Students will be able to:

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Syllabus

Unit I	Hours=24
Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.	4
Unit II	
Repercussions of Disasters and Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Manmade disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	5
Unit III	
Disaster Prone Areas In India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides and Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.	4
Unit IV	
Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.	5
Unit V	
Risk Assessment and Mitigation	6

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs Of Disaster Mitigation in India.	

SUGGESTED READINGS:

1. R. Nishith, A.K, Singh, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company.
2. Pardeep Sahni , "Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. S. L. Goel, "Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi.

COURSE OUTCOMES:

Students will be able to

- develop a solid understanding of Disaster Management key concepts, models and frameworks
- develop a solid understanding of Risk assessment
- develop understanding about different government schemes of disaster management and risk assessment

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C. Sanskrit for Technical Knowledge

Course Code	MCSE 106/205 C
Course Name	Sanskrit for Technical Knowledge
Credits	0
Pre-Requisites	NIL

COURSE OBJECTIVES:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world.
- Learning of Sanskrit to improve brain functioning.
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

Unit I	Hours=24
Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences	8
Unit II	
Order Introduction of roots Technical information about Sanskrit Literature	8
Unit III	
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	8

Suggested readingS

1. Dr.Vishwas ,"Abhyaspustakam" –, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. Suresh Soni, "India's Glorious Scientific Tradition", Ocean books (P) Ltd., New Delhi.

COURSE OUTCOME

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

D. Value Education

Course Code	MCSE 106/205 D
Course Name	Value Education
Credits	0
Pre-Requisites	NIL

COURSE OBJECTIVES:

Students will be able to

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Syllabus

Unit I	Hours=22
Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgments	4
Unit II	
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.	6
Unit III	
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labor. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature	6
Unit IV	
Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively	6

Suggested readingS

1. S.K. Chakroborty, “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi.

COURSE OUTCOMES:
Students will be able to

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

E. Constitution of India

Course Code	MCSE 106/205 E
Course Name	Constitution of India
Credits	0
Pre-Requisites	NIL

COURSE OBJECTIVES:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Syllabus

Unit I	Hours=24
History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working) **Philosophy of the Indian Constitution:** Preamble Salient Features	5
Unit II	
Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.	5
Unit III	
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions	5
Unit IV	
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	5

Unit V	
Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	4

Suggested readings

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

COURSE OUTCOMES:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

F. Pedagogy Studies

Course Code	MCSE 106/205 F
Course Name	PEDAGOGY STUDIES
Credits	0
Pre-Requisites	NIL

COURSE OBJECTIVES:

Students will be able to:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Syllabus

Unit I	Hours=24
Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and Terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.	5
Unit II	
Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.	4
Unit III	
Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.	7
Unit IV	
Professional development: Alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes	4
Unit V	
Research gaps and future directions Research design, Contexts, Pedagogy, Teacher education □ Curriculum and assessment, Dissemination and research impact.	4

Suggested reading

1. Ackers J, F Hardman Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261. 2001.
2. M. Agrawal, Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379, (2004).
3. K. Akyeampong, Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID, 2003.
4. K .Akyeampong, K. Lussier, J. Pryor, J . Westbrook, Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282, 2013.
5. Alexander RJ, Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell, 2001.
6. M. Chavan, Read India: A mass scale, rapid, 'learning to read' campaign, 2003.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

COURSE OUTCOMES:

Students will be able to understand:

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

G. Stress Management by Yoga

Course Code	MCSE 106/205 G
Course Name	Stress Management by Yoga
Credits	0
Pre-Requisites	NIL

COURSE OBJECTIVES:

- To achieve overall health of body and mind
- To overcome stress

Syllabus

Unit I	Hours=24
Definitions of Eight parts of yog. (Ashtanga)	8
Unit II	
Yam and Niyam. Do`s and Don't's in life. I. Ahinsa, satya, astheya, bramhacharya and aparigraha II. Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
Unit III	
Asan and Pranayam I. Various yog poses and their benefits for mind & body II. Regularization of breathing techniques and its effects-Types of pranayam	8

Suggested reading

1. "Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

COURSE OUTCOMES:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

H. Personality Development through Life Enlightenment Skills

Course Code	MCSE 106/205 H
Course Name	Personality Development through Life Enlightenment Skills.
Credits	0
Pre-Requisites	NIL

COURSE OBJECTIVES:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in student

Syllabus

Unit I	Hours=24
Neetisatakam-Holistic development of personality I. Verses- 19,20,21,22 (wisdom) II. Verses- 29,31,32 (pride & heroism) III. Verses- 26,28,63,65 (virtue) IV. Verses- 52,53,59 (dont's) V. Verses- 71,73,75,78 (do's)	8
Unit II	
Approach to day to day work and duties. Shrimad BhagwadGeeta : I. Chapter 2-Verses 41, 47,48, II. Chapter 3-Verses 13, 21, 27, 35, III. Chapter 6-Verses 5,13,17, 23, 35, IV. Chapter 18-Verses 45, 46, 48.	8
Unit III	
Statements of basic knowledge. Shrimad BhagwadGeeta: I. Chapter2-Verses 56, 62, 68 II. Chapter 12 -Verses 13, 14, 15, 16,17, 18 Personality of Role model. Shrimad BhagwadGeeta: I. Chapter2-Verses 17, II. Chapter 3-Verses 36,37,42, III. Chapter 4-Verses 18, 38,39 IV. Chapter18 – Verses 37,38,63	8

Suggested reading

1. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,
3. Rashtriya Sanskrit Sansthanam, New Delhi.**COURSE OUTCOMES:**

COURSE OUTCOMES:

Students will be able to

- Study of the Shrimad- Bhagwad- Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied the Geeta will lead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.

Elective Courses

Elective I
A. Advanced Operating System

Course Code	MCSE 104 A
Course Name	Advanced Operating System
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Operating System

COURSE OBJECTIVES:

- To Understand the working of a distributed Operating system
- To understand the issues in designing a distributed Operating System.
- To understand the synchronization primitives of interaction of distributed Operating System
- To understand the construct and functioning of Distributed shared – memory and Deadlock management in distributed environment.
- To understand the various failure modes of the system and failure recovery in a distributed environment.

Syllabus

UNIT I	Hours =40
Architectures of Distributed Systems - System Architecture types - issues in distributed operating systems - communication networks – communication primitives. Concept of a Process, Concurrent Processes – The Critical Section Problem, Other Synchronization Problems – Language Mechanisms for Synchronization – Axiomatic Verification of Parallel Programs.	8
UNIT II	
Theoretical Foundations - inherent limitations of a distributed system – lamport's logical clocks – vector clocks – casual ordering of messages – global state – cuts of a distributed computation – termination detection. Distributed Mutual Exclusion – introduction – the classification of mutual exclusion and associated algorithms – a comparative performance analysis.	8
UNIT III	
Distributed Deadlock Detection -Introduction - deadlock handling strategies in distributed systems – issues in deadlock detection and resolution – control organizations for distributed deadlock detection – centralized and distributed deadlock detection algorithms –hierarchical deadlock detection algorithms. Agreement protocols – introduction-the system model, a classification of agreement problems, solutions to the Byzantine agreement problem, applications of agreement algorithms.	8

Distributed resource management: introduction-architecture – mechanism for building distributed file systems – design issues – log structured file systems.	
UNIT IV	
Distributed shared memory-Architecture– algorithms for implementing DSM – memory coherence and protocols – design issues. Distributed Scheduling – introduction – issues in load distributing – components of a load distributing algorithm – stability – load distributing algorithm – performance comparison – selecting a suitable load sharing algorithm – requirements for load distributing -task migration and associated issues	8
UNIT V	
Failure Recovery and Fault tolerance: introduction– basic concepts – classification of failures – backward and forward error recovery, backward error recovery- recovery in concurrent systems – consistent set of check points – synchronous and asynchronous check pointing and recovery – check pointing for distributed database systems- recovery in replicated distributed databases.	8

Text Books:

1. Mukesh Singhal, Niranjan G. Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", TMH, 2001

Reference books:

1. Andrew S. Tanenbaum, "Modern operating system", PHI, 2003
2. Pradeep K. Sinha, "Distributed operating system-Concepts and design", PHI, 2003.
3. Andrew S. Tanenbaum, "Distributed operating system", Pearson education, 2003

COURSE OUTCOMES:

- The course will help the students to understand the basic aim and scope of Distributed Operating System.
- The Course will help students in analyzing the various issues in designing a Distributed Operating system and also give insight into various solutions to overcome the issues at hand.
- Deep understanding of deadlock handling and synchronization primitives of various algorithms in distributed environment.
- Understanding of process scheduling and implementation of memory coherence, load balancing, processor to processor interaction.
- Deep understanding of Failure recovery and fault tolerance.

B. Natural Language Processing

Course Code	MCSE 104 B
Course Name	Natural Language processing
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Basic programming skills General understanding of Statistics

COURSE OBJECTIVES:

This course introduces the fundamental concepts and techniques of natural language processing (NLP). It provides the understanding of the computational properties of natural languages and the algorithms for processing linguistic information. The course will introduce both linguistic (knowledge-based) and statistical approaches to NLP, illustrate the use of NLP techniques and tools in a variety of application areas, and provide insight into many open research problems.

Syllabus

UNIT I	Hours=40
Introduction: Introduction to NLP, challenges of NLP ,Phases in natural language processing, applications Language Modeling: Grammar-based LM, Statistical LM Regular Expression, Finite State Automata, Morphology and Finite State Transducers N-grams, Smoothing, HMM and Speech Recognition: Speech Recognition Architecture, Overview of HMM. Evaluation of language models.	8
UNIT II	
Word Classes and Part-of-Speech Tagging: English word classes, Targets for English, Part of speech Tagging, Rule Based part of speech Tagging, Stochastic part of speech Tagging ,HMM,Transformation Based Tagging. Handling of unknown words, named entities, multi word expressions. Context Free Grammars for English: Constituency, Context Free rules and Trees, Sentence level construction, The Noun Phrase, Coordination, Agreement, The verb phrase and sub-categorization. Parsing with context free grammars: Basic Top down Parser, and Bottom-up parsing, the early Algorithm, Finite state parsing method Features and Unifications: Feature structures, Unification of Features Structures, Features Structures in the grammar, Implementing Unification. Lexicalized and probabilistic parsing: Probabilistic context free grammars, problems with probabilistic context free grammars, probabilistic lexicalized GFG	8
UNIT III	
Semantics Representing Meaning: Meaning structure of language,	8

First order predicate calculus, linguistically relevant concept, Related Re-presentational approaches, Alternative approaches to meaning. Semantic Analysis: Syntax driven semantic analysis, Attachment of Fragment of English,. Robust Semantic Analysis. Lexical Semantics: Relation among lexemes and their senses, Internal Structure of words. WordNet ,Word Sense Disambiguation- Selectional restriction, machine learning approaches, dictionary based approaches.	
UNIT IV	
Pragmatics Discourse: Reference resolution, Text Coherence, Discourse Structure, constraints on co-reference algorithm for pronoun resolution Psycholinguistics Studies of reference and coherence. Natural Language generation: Introduction to language generation, Architecture for generation, , Discourse planning.	8
UNIT V	
Applications of NLP- Introduction to corpus elements in balanced corpus, TreeBank, PropBank, WordNet, VerbNet etc. stemmers and lemmatiser, Spell-checking, Summarization Information Retrieval-Vector space model, term weighting, Machine Translation–Overview	8

Text and Reference Books:

1. Jurafsky, Dan and Martin, James, **Speech and Language Processing**, Second Edition, Prentice Hall, 2008.
2. Tanveer Siddiqui, U.S. Tiwary, ―Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
3. Allen, James, **Natural Language Understanding**, Second Edition, Benjamin/Cumming, 1995.
4. Manning, Christopher and Heinrich, Schutze, **Foundations of Statistical Natural Language Processing**, MIT Press, 1999.
5. Richard M Reese, ―Natural Language Processing with Java, OReilly Media, 2015.
6. NitinIndurkhya and Fred J. Damerau, ―Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.

COURSE OUTCOMES:

1. Understand core algorithms and data structures used in NLP
2. Apply these mathematical models and algorithms in applications in software design and implementation for NLP.
3. Upon completion of the subject, students will be able to: (a) Understand the fundamental mathematical models and algorithms in the field of NLP. (b) Apply these mathematical models and algorithms in applications in software design and

implementation for NLP. (c) Understand the principles of language resource annotation and its use in machine learning applications and apply the above principles in analysis of data and acquire intended information through the use of available tools. (d) Understand the design and implementation issues in various NLP applications such as information retrieval and information extraction. (e) Understand the complexity of speech and the challenges facing speech engineers. (f) Understand the principles of automatic speech recognition and synthesis. (g) Problem solving using systematic ways and learning independently

4. Develop NLP components, such as n-gram language models stemmer, part-of-speech taggers
5. Evaluate the merits of use of different statistical approaches for different types NLP tasks
6. Implement a simple NLP systems;

C. Advanced Statistical Methods

Course Code	MCSE 104 C
Course Name	Advanced Statistical Methods
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Linear algebra and calculus. Knowledge of probability theory, statistics and programming is desirable.

COURSE OBJECTIVES:

- To familiarize students with advanced paradigms of statistical data analysis
- To familiarize students with the broad contours of the different types of data analytics, namely, descriptive, inferential
- Applicability of the tests and hypothesis

Syllabus

UNIT I	Hours=40
Introductory Probability: Defining Random Variables (RVs): Events, Measurability, Independence, Sample Spaces, Events, Measures, Probability Independence, Conditional probability, Bayes' theorem Random Variables RVs: Bernoulli, Binomial, Geometric, Poisson; Uniform, Exponential, Normal, Lognormal Expectations, Moments and Moment generating functions	8
UNIT II	
Probability functions. Binomial, multinomial, Poisson, uniform, exponential, Gaussian, chi-square, Cauchy distributions. The Monte Carlo method. Random number generators, the transformation method, the acceptance-rejection method. **Parameter estimation:** general concepts. Samples, estimators, bias. Estimators for mean, variance, covariance**.**	7
UNIT III	
The method of maximum likelihood. The likelihood function, ML estimators for parameters of Gaussian and exponential distributions. Variance of ML estimators, the information inequality, extended ML, ML with binned data. **The method of least squares.** Relation to maximum likelihood, linear least squares fit, LS with binned data, testing goodness-of-fit, combining measurements with least squares. **Statistical tests.** Significance and power of a test, choice of the critical region. Constructing test statistics: the Fisher discriminant, neural networks, etc. Testing goodness-of-fit, chi^2-test, P-values.	10
UNIT IV	
Interval estimation. Classical confidence intervals: with Gaussian	8

distributed estimator, for mean of Poisson variable. Setting limits, limits near a physical boundary **Differentiating algorithmic and model based frameworks** Regression : Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbors Regression & Classification	
UNIT V	
Advanced Methods: Random Forest, Neural Networks, Deep learning , SVM,Clustering, Associative Rule Mining, Challenges for big data analytics	7

Suggested Readings:

1. Hastie, Trevor, The elements of statistical learning. Vol. 2. No. 1. New York: springer, 2009
2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley &Sons, 2010

COURSE OUTCOMES:

After completion of course, students would be able to:

- Recognize underlying statistical foundations of data analytics
- Obtain hands-on experience by implementing the popular algorithms for classification, regression and clustering problems.
- Gain in-depth understanding for converting information into knowledge

D. Wireless Sensor Networks

Course Code	MCSE 104 D
Course Name	Wireless Sensor Networks
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Computer Networks

COURSE OBJECTIVES:

- Architect sensor networks for various application setups.
- Devise appropriate data dissemination protocols and model links cost.
- Understanding of the fundamental concepts of wireless sensor networks and have a basic knowledge of the various protocols at various layers.
- Evaluate the performance of sensor networks and identify bottlenecks.

Syllabus

UNIT I	Hours = 40
Introduction to Wireless Sensor Networks: Introduction to Wireless Sensor Networks: Motivations, Applications, Performance metrics, History and Design factors , Network Architecture: Traditional layered stack, Cross-layer designs, Sensor Network Architecture Hardware Platforms: Motes, Hardware parameters	10
UNIT II	
Medium Access Control Protocol Design: Fixed Access, Random Access, WSN protocols: synchronized, duty-cycled **Introduction to Markov Chain:** Discrete time Markov Chain definition, properties, classification and analysis **MAC Protocol Analysis:** Asynchronous duty-cycled. X-MAC Analysis (Markov Chain)	8
UNIT III	
Routing protocols: Introduction, MANET protocols **Routing protocols for WSN:** Resource-aware routing, Data-centric, Geographic Routing, Broadcast, Multicast **Opportunistic Routing Analysis:** Analysis of opportunistic routing (Markov Chain)	10
UNIT IV	
Security: Possible attacks, countermeasures, SPINS, Static and dynamic key distribution	7
UNIT V	
Advanced topics in wireless sensor networks: Recent development in WSN standards, software applications.	5

Reference books:

1. W. Dargie and C. Poellabauer, “Fundamentals of Wireless Sensor Networks –Theory and Practice”, Wiley 2010
2. KazemSohraby, Daniel Minoli and TaiebZnati, “Wireless Sensor Networks - Technology, Protocols, and Applications”, Wiley Interscience 2007
3. Takahiro Hara,Vladimir I. Zadorozhny, and Erik Buchmann, “Wireless Sensor Network Technologies for the Information Explosion Era”, Springer 2010

COURSE OUTCOMES

- Describe and explain radio standards and communication protocols for wireless sensor networks.
- Explain the function of the node architecture and use of sensors for various applications.
- Be familiar with architectures, functions and performance of wireless sensor networks systems and platforms.

E. Data Mining and Data Warehousing

Course Code	MCSE 104 E
Course Name	Data Mining and Data Warehousing
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Databases, Probability

COURSE OBJECTIVES

- To introduce data warehousing and mining techniques.
- Application of data mining in web mining, pattern matching and cluster analysis is included to aware students of broad data mining areas.

Syllabus

UNIT I	Hours = 42
Introduction to Data Warehousing; Data Mining: Mining frequent patterns, association and correlations; Sequential Pattern Mining concepts, primitives, scalable methods; Integration of a Data Mining System with a Data Warehouse; Data Preprocessing	9
UNIT II	
Classification and prediction: Classification and prediction; Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods; Transactional Patterns and other temporal based frequent patterns	8
UNIT III	
Mining Time-Series: Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, Similarity search in Time-series analysis.	7
UNIT IV	
Mining Data Streams, Graph Mining, Social Network Analysis: Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams, Class Imbalance Problem; Graph Mining ,Social Network Analysis	9
UNIT V	
Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining. Recent trends in Distributed Warehousing and Data Mining,	9

Text Books:

1. JiaweiHan , M Kamber and J Pei " Data Mining Concepts and Techniques", Third Edition, Elsevier Publication, 2011.
2. Pang-Ning Tan, Michael Steinbach and Vipin Kumar "Introduction to Data Mining", Pearson Education, 2007

Reference books:

1. Alex Berson and Stephen J. Smith "Data Warehousing, Data Mining & OLAP", Tata McGraw – Hill Edition, Tenth Reprint 2007.
2. G.K. Gupta – Introduction to Data Mining with case Studies, PHI, New Delhi – 2006.
3. A. Berson& S.J. Smith – Data Warehousing Data Mining, COLAP, TMH, New Delhi, 2004

COURSE OUTCOMES:

After completion of course, students would be:

- Study of different sequential pattern algorithms
- Study the technique to extract patterns from time series data and it application in real world.
- Can extend the Graph mining algorithms to Web mining
- Help in identifying the computing framework for Big Data

Elective-II
A. Advance Database Management Systems

Course Code	MCSE 203 A
Course Name	Advance Database Management Systems
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Database Management System

COURSE OBJECTIVES:

- Master transaction processing, concurrency control and crash recovery
- Master query processing and optimization
- Master advanced indexing and data organization for DBMS
- Master different types of Databases

Syllabus

UNIT I	Hours =42
Introduction to different types of databases, Normal Forms and advanced normal forms, Introduction to Relational Algebra, SQL and PL- SQL	9
UNIT II	
Transaction Concepts, Transaction states, Concurrent Execution, Concurrency Control like Lock based protocols, Timestamp – Based protocols etc, Recovery Systems.	9
UNIT III	
Indexing and Hashing, B – Tree, B+ - Tree, ISAM, R – Trees, R*- Trees etc	9
UNIT IV	
Distributed Databases, Distributed storage, Distributed Transactions, Commit protocols, Concurrency Control in Distributed Databases, Distributed Query Processing	9
UNIT V	
Introduction to Parallel Databases, I/O parallelism, Interquery parallelism, Inraquery Parallelism, Interoperation and intraoperation parallelism.	6

Text Books:

1. Database System Concepts, International Edition, Silberscatz, Korth, Sudarshan.
2. Fundamentals of Database Systems, 6th Edition, Elmasri and Navathe

COURSE OUTCOMES:

- Explain in detail DBMS architecture.

- Explain in detail advanced query processing and techniques involved in query optimization.
- Explain the principles of concurrency control.
- Explain the principles of recovery management.

B. Pattern Recognition

Course Code	MCSE 203 B
Course Name	Pattern Recognition
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	NIL

COURSE OBJECTIVES:

1. To study basics of Pattern Recognition
2. To study the estimation of unknown PDF
3. To study linear classifiers and nonlinear classifiers

Syllabus

UNIT I: INTRODUCTION	Hours =40
Importance of pattern recognition, Features, Feature Vectors, and Classifiers, Supervised, Unsupervised, and Semi-supervised learning, Introduction to Bayes Decision Theory, Discriminant Functions and Decision Surfaces, Gaussian PDF and Bayesian Classification for Normal Distributions.	8
UNIT II: DATA TRANSFORMATION AND DIMENSIONALITY REDUCTION	
Introduction, Basis Vectors, The Karhunen Loeve (KL) Transformation, Singular Value Decomposition, Independent Component Analysis (Introduction only). Nonlinear Dimensionality Reduction, Kernel PCA	8
UNIT III: ESTIMATION OF UNKNOWN PROBABILITY DENSITY FUNCTIONS	
Maximum Likelihood Parameter Estimation, Maximum a Posteriori Probability estimation, Bayesian Interference, Maximum Entropy Estimation, Mixture Models, Naive-Bayes Classifier, The Nearest Neighbor Rule.	8
UNIT IV: LINEAR CLASSIFIERS	
Introduction, Linear Discriminant Functions and Decision Hyperplanes, The Perceptron Algorithm, Mean Square Error Estimate, Stochastic Approximation of LMS Algorithm, Sum of Error Estimate.	8
UNIT V: NONLINEAR CLASSIFIERS	
The XOR Problem, The two Layer Perceptron, Three Layer Perceptron, Back propagation Algorithm, Basic Concepts of Clustering, Introduction to Clustering , Proximity Measures.	8

Text Books:

2. *S. Theodoridis and K. Koutroumbas,"Pattern Recognition", (4th Ed.)- Elsevier ,2014.*
3. *Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2013.*

Reference books:

1. *Tom M. Mitchell (Indian Edition),"Machine Learning ", McGraw Hill Education ,2013.*
2. *M Narasimha Murty and V Susheela Devi, "Pattern Recognition: An Algorithmic Approach" Universities Press ,2011.*

COURSE OUTCOMES:

- Students will be able to interact with interdisciplinary course.
- Students will be able to understand the concept of dimensionality reduction.
- Students will demonstrate the skills of classification using linear and nonlinear classifiers to solve the industrial problems.
- Students will know the design pre-requisites and design procedure of pattern recognition.
- Students will understand the concept of pattern classification and pattern association and will try to implement in project work.

C. Image Processing

Course Code	MCSE 203C
Course Name	Image Processing
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	NIL

COURSE OBJECTIVES:

- To become familiar with digital image fundamentals
- Be exposed to simple image processing techniques.
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.
- Learn to represent image in form of features.

Syllabus

UNIT I:	Hours = 44
Digital Image Fundamentals Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels – neighborhood, adjacency, connectivity, distance measures, Color image fundamentals – RGB, HSI models.	8
UNIT II:	
Image Enhancements Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering–Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.	7
UNIT III:	
Image Restoration Image Restoration – degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering.	7
UNIT IV:	
Image Segmentation Edge detection, Edge linking via Hough transform – Thresholding – Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.	7

UNIT V: Color Image Processing and Wavelets	
Color models–RGB, YUV, HSI; Color transformations– formulation, color complements, color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation. Uncertainty principles of Fourier Transform, Time frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Sub band filter banks, wavelet packets.	8
UNIT VI:	
Morphological Image Processing Preview and Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Operation, Some Basic Morphological Algorithms – Boundary Extraction, Extraction of Connected Components, Convex Hull, Thinning and Thickening. Gray Scale Morphology.	7

Text Books:

1. Rafael C. Gonzalez, Richard E. Woods,Digital Image Processing Pearson, Third Edition, 2010.
2. Anil K. Jain,Fundamentals of Digital Image Processing Pearson, 2002.

Reference books:

1. Kenneth R. Castleman,Digital Image Processing Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB Pearson Education, Inc., 2011.
3. D, E. Dudgeon and RM. Mersereau, Multidimensional Digital Signal Processing Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, Digital Image Processing John Wiley, New York, 2002
5. Milan Sonka et al Image processing, analysis and machine vision Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.

COURSE OUTCOMES:

At the end of the course, the students should be able to:

- Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.
- Operate on images using the techniques of smoothing, sharpening and enhancement.
- Understand the restoration concepts and filtering techniques.
- Learn the basics of segmentation, features extraction, compression and recognition methods for color models.

D. Cryptography & Network Security

Course Code	MCSE 203 D
Course Name	Cryptography & Network Security
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Computer Networks, Discrete Mathematics, Web Programming

COURSE OBJECTIVES:

Students will try to learn:

- The concepts of classical encryption techniques and concepts of finite fields and number theory.
- And explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms
- And explore the design issues and working principles of various authentication Protocols.
- And explore various secure communication standards including Kerberos, IPsec, and SSL/TLS and email.
- The ability to use existing cryptographic utilities to build programs for secure communication.
- The concepts of cryptographic utilities and authentication mechanisms to design secure applications
- To get an insight of various issues of Web security and biometric authentication.

Syllabus

UNIT I	Hours = 44
Introduction and Mathematical Foundations: Overview on Modern Cryptography, Ciphers and Secret Messages, Security Attacks and Services. Number Theory, Probability and Information Theory, Mathematical Tools for Cryptography: Substitutions and Permutations, Modular Arithmetic, Euclid's Algorithm, Finite Fields, Polynomial Arithmetic, Discrete Logarithms. Classical Cryptosystems, Cryptanalysis of Classical Cryptosystems	8
UNIT II	
Conventional and Modern Symmetric Encryption Algorithms: Theory of Block Cipher Design, Feistel Cipher Network Structures, DES and Triple DES, Modes of Operation (ECB, CBC, OFB, CFB), Strength (or Not) of DES. Modern Symmetric Encryption Algorithms: IDEA, Blowfish, Rijndael (AES), Key Distribution. Stream Ciphers and Pseudo Random Numbers: Pseudo random sequences, Linear Congruential Generators, Cryptographic Generators, Design of Stream Cipher, One Time Pad, Cryptanalysis of Symmetric Key Ciphers.	8
UNIT III	
Public Key Cryptography, Hashes and Message Digests:	8

Prime Numbers and Testing for Primality, Factoring Large Numbers, RSA, Diffie-Hellman, ElGamal, Key Exchange Algorithms, Public-Key Cryptography Standards. Hashes and Message Digests: Message Authentication, MD5, SHA, RIPEMD, HMAC, Cryptanalysis of Asymmetric Key Ciphers, Modern Trends in Asymmetric Key Cryptography.	
UNIT IV	
Digital Signatures, Certificates, User Authentication: Digital Signature Standard (DSS and DSA), Security Handshake Pitfalls, Elliptic Curve Cryptosystems. Authentication of Systems: Kerberos V4 and V5, X.509 Authentication Service. Digital Watermarking and Steganography.	6
UNIT V	
Network Security: Secret Sharing Schemes, Network Protocols, Pretty Good Privacy (PGP), Secure Socket Layer (SSL), Transport Layer Security (TLS), Secure/Multipurpose Internet Mail Extensions (S/MIME), Intruders and Viruses, Intrusion Detection Systems, Honey pots. Firewalls, IPSEC, Web Security, SQL injection, privilege management infrastructure (PMI) and Access Control	8
UNIT VI	
Biometric and IOT Security: Biometric authentication, Secure E-Commerce (ex. SET), Smart Cards, Security in Wireless Communication. recent trends in IOT security, IDS and Biometric.	6

Text Books:

1. William Stallings, Cryptography and Network Security, Principles and Practice, 7th Edition, Pearson Education, 2017.
2. Bruce Schneier, "Applied cryptography: protocols, algorithms, and source code in C"(20th Anniversary Ed.), John Wiley & Sons, 2015.
3. Lawrence Miller, "IoT Security for Dummies" John Wiley & Sons, 2016.

Reference Books:

1. *Behrouz A. Ferouzan, "Cryptography & Network Security", Tata McGraw Hill.*
2. *Mollin, Richard A. "An introduction to cryptography."(2nd Ed.) CRC Press, 2006.*

COURSE OUTCOMES

- Identify information security goals, classical encryption techniques and acquire fundamental knowledge on the concepts of finite fields and number theory.
- Understand, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication
- Apply the knowledge of cryptographic checksums and evaluate the performance of different message digest algorithms for verifying the integrity of varying message sizes.
- Apply different digital signature algorithms to achieve authentication and create secure applications.

- Apply network security basics, analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP.
- Apply the knowledge of cryptographic utilities and authentication mechanisms to design secure applications
- Understanding of biometric techniques available and how they are used in today's world.

E. Data Science

Course Code	MCSE 203 E
Course Name	Data Science
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Algorithms and Data Structure (Desirable), Basic linear algebra, Pasic probability and statistics.

COURSE OBJECTIVES:

- Provide you with the knowledge and expertise to become a proficient data scientist.
- Demonstrate an understanding of statistics and machine learning concepts that are vital for data science;
- Produce Python code to statistically analyses a dataset;
- Critically evaluate data visualizations based on their design and use for communicating stories from data;

UNIT I:	Hours=44
Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.	6
UNIT II:	
Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources	7
UNIT III:	
Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.	7
UNIT IV:	
Data visualization: Introduction, Types of data visualization, Data for visualization: Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings.	10
UNIT V:	
Applications of Data Science, Technologies for visualization, Bokeh (Python)	7
UNIT VI:	
Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.	7

Text Books:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline.
   O'Reilly. 2014
2. Jure Leskovek, AnandRajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014. (free online)

Reference books:

1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. ISBN 0262018020. 2013.
2. Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Elements of Statistical Learning, Second Edition. ISBN 0387952845. 2009. (free online)

COURSE OUTCOMES

- Explain how data is collected, managed and stored for data science;
- Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists;
- Implement data collection and management scripts using MongoDB

Elective-III
A. Advanced Computer Architecture

Course Code	MCSE 204A
Course Name	Advanced Computer Architecture
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Computer Organization and Architecture

COURSE OBJECTIVES

- The student should be made to:
- Understand the micro-architectural design of processors.
- Learn about the various techniques used to obtain performance improvement and power savings in current processors.

Syllabus

UNIT I PIPELINING BASIC AND INTERMEDIATE CONCEPT	Hours=44
Review of Fundamentals of CPU, Memory and IO – Trends in technology, power, energy and cost, Dependability - Performance Evaluation Review of Pipelining, Examples of some pipeline in modern processors, pipeline hazards, data hazards, control hazards. Techniques to handle hazards, performance improvement with pipelines and effect of hazards on the performance	10
UNIT II **INSTRUCTION LEVEL PARALLELISM**	
ILP concepts – Pipelining overview - Compiler Techniques for Exposing ILP – Dynamic Branch Prediction – Dynamic Scheduling – Multiple instruction Issue – Hardware Based Speculation – Static scheduling - Multi-threading - Limitations of ILP – Case Studies of Intel core i7 and ARM Cortex A8	10
UNIT III **DATA-LEVEL PARALLELISM**	
Vector architecture – SIMD extensions – Graphics Processing units – Loop level parallelism	7
UNIT IV **THREAD LEVEL PARALLELISM**	
Symmetric and Distributed Shared Memory Architectures – Performance Issues –Synchronization – Models of Memory Consistency – Case studies: Intel i7 Processor, SMT & CMP Processors	8
UNIT V	
Cache Performance – Reducing Cache Miss Penalty and Miss Rate – Reducing Hit Time – Main Memory and Performance – Memory Technology.	9

Text Books:

1. John L Hennessey and David A Patterson, “Computer Architecture A Quantitative Approach”, Morgan Kaufmann/ Elsevier, Fifth Edition, 2012.

Reference books:

1. Kai Hwang and Faye Briggs, “Computer Architecture and Parallel Processing”, Mc Graw-Hill International Edition, 2000.

2. Sima D, Fountain T and Kacsuk P, ”Advanced Computer Architectures: A Design Space Approach”, Addison Wesley, 2000.

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Evaluate performance of different architectures with respect to various parameters
- Study about different hazards and its resolution
- Analyze performance of different ILP techniques
- Identify cache and memory related issues in multi-processors

B. Information Storage and Retrieval

Course Code	MCSE 204B
Course Name	Information Storage and Retrieval
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Any Programming Language (Preferably java), Probability and linear algebra

COURSE OBJECTIVES:

- To learn and study algorithms which will enable to design, and implement modern information retrieval systems
- To investigate search evaluation, retrieval feedback, search log mining, and applications in web information management.
- To familiarize students with advanced paradigms of information retrieval

Syllabus

UNIT I	Hours=40
Introduction: concepts and terminology of information retrieval systems, Significance of information retrieval and storage, Information Retrieval Vs Information Extraction; Indexing: inverted files, encoding, Zipf's Law, compression, boolean queries;	10
UNIT II	
Fundamental IR models: Boolean, Vector Space, probabilistic, TFIDF, Okapi, language modeling, latent semantic indexing, query processing and refinement techniques	9
UNIT III	
Performance Evaluation: precision, recall, F-measure; Classification: Rocchio, Naive Bayes, k-nearest neighbors, support vector machine	6
UNIT IV	
Clustering: partitioning methods, k-means clustering, hierarchical; Introduction to advanced topics: search, relevance feedback, ranking, query expansion.	8
UNIT V	
Recent trends and domains of Information Retrieval, Similarity And Distance Measures–Snippet Generation, Summarization, Question Answering, Cross-Lingual Retrieval and Modern Search Applications	7

Suggested Readings:

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schtze, Introduction to Information Retrieval, Cambridge University Press. 2008

2. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, Modern Information Retrieval, Addison Wesley, 1st edition, 1999.
3. Soumen Chakrabarti, Mining the Web, Morgan-Kaufmann Publishers, 2002.
4. Bing Liu, Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, Springer, Corr. 2nd printing edition, 2009.
5. David A. Grossman, Ophir Frieder, Information Retrieval: Algorithms and Heuristics, Springer, 2nd edition, 2004.
6. William B. Frakes, Ricardo Baeza-Yates, Information Retrieval Data Structures and Algorithms, Prentice Hall, 1992.
7. G. Salton, M. J. McGill, Introduction to Modern Information Retrieval, McGraw-Hill, 1986.
8. C. J. Van Rijsbergen, Information Retrieval, Butterworth-Heinemann; 2nd edition, 1979.

COURSE OUTCOMES:

After completion of course, students would be able to:

- Recognize underlying technologies of modern information retrieval system
- Obtain hands-on experience by using existing information retrieval toolkits to set up your own search engines and improving their search accuracy.
- Helps in gaining in-depth understanding of the methods like document text-mining techniques, page-rank etc. and develop your own idea for new solutions for cross-lingual IR

C. Machine Learning

Course Code	MCSE 204C
Course Name	Machine Learning
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	NIL

COURSE OBJECTIVES:

- To impart the basic concepts of machine learning and algorithms.
- To understand concepts about supervised and unsupervised learning
- To understand basic concepts about deep learning and learning theory.
- To enable them to understand issues related to the application of machine learning

Syllabus

UNIT I	Hours=40
Fundamentals: Introduction, Different Types of Learning, Hypothesis Space and Inductive Bias, Evaluation and Cross-Validation, Linear Regression Introduction to Decision Trees Learning Decision Tree, Overfitting	8
UNIT II	
Supervised learning: Supervised learning setup, LMS, Logistic regression, Perceptron, Exponential family, Generative learning algorithms, Gaussian discriminant analysis, Naive Bayes, Support vector machines	9
UNIT III	
Learning theory: , Model selection and feature selection, Ensemble methods: Bagging, boosting, Evaluating and debugging learning algorithms;.Bias/variance tradeoff, Union and Chernoff/Hoeffding bounds, VC dimension, Worst case (online) learning;.	7
UNIT IV	
Unsupervised learning: Clustering K-means, EM. Mixture of Gaussians, Factor analysis, PCA (Principal components analysis), ICA (Independent components analysis);	6
UNIT V	
Reinforcement learning and control: MDPs. Bellman equations, Value iteration and policy iteration, Linear quadratic regulation (LQR), LQG, Q-learning. Value function ,approximation, Policy search. Reinforce. POMDPs.	8

Text Books:

1. EthemAlpaydin, Introduction to Machine Learning, 3rd Edition, PHI, 2015
2. Tom M. Mitchell, Machine Learning, McGraw Hill Education; First edition (1 July 2017)

Reference books:

1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning: Data Mining, Inference, and Prediction., Second Edition 2009.
2. Christopher Bishop. Pattern Recognition and Machine Learning, Springer; 2011 edition (15 February 2010).

COURSE OUTCOMES

- For a given problem student will able to analyze and implement the solution using
  - linear regression,
  - logistic regression, decision trees, k-nearest neighbour,
  - Bayesian learning and the naïve Bayes algorithm,
  - support vector machines and kernels
  - neural networks to determine and justify the correctness.

D. Network on Chip

Course Code	MCSE 204D
Course Name	Network on Chip(NoC)
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Computer networks and Data Communication

COURSE OBJECTIVES:

- To introduce basic interconnection networks and its various uses
- To introduce popular topologies in Noc
- To introduce Routing and routing mechanics in Noc
- To introduce flow control and QoS premitives in NoC

Syllabus

UNIT I	Hours =40
Introduction to Interconnection Networks: Uses of Interconnection Networks ,**Network Basics :**Topology, Routing Flow Control, Router Architecture , Performance of Interconnection Networks.	8
UNIT II	
Topology Basics : Channels and Nodes , Direct and Indirect Networks , Cuts and Bisections , Paths , **Traffic Patterns** , **Performance** , Throughput and Maximum Channel Load Latency , Path Diversity, **Packaging Cost** . **Basics of Popular Topologies :** Butterfly Networks: Structure, Performance, Packaging cost, Path diversity, Number of Stages. Torus Networks: Structure, Performance, Packaging cost, Path diversity. Meshes and Express cubes	8
UNIT III	
Routing Basics: Taxonomy of Routing Algorithms , The Routing Relation , Deterministic Routing , Oblivious Routing , Minimal Oblivious Routing , Load-Balanced Oblivious Routing, Adaptive Routing, Routing Mechanics.	8
UNIT IV	
Flow Control Basics: Resources and Allocation Units , Bufferless Flow Control , Circuit Switching , Buffered Flow Control , Packet-Buffer Flow Control, Flit-Buffer Flow Control , Buffer Management and Backpressure , Flit-Reservation Flow Control	8
UNIT V	
Deadlock and Livelock: Deadlock , Deadlock Avoidance, Adaptive	8

Routing, Deadlock Recovery , Livelock **Quality of Service** : Burstiness and Network , Implementation of Guaranteed Services Delays , Implementation of Best-Effort Services, Separation of Resources	

Text Books:

1. "Principle and Practices of Interconnection Networks", William J. Dally and brain Towles, Morgankaufmann.

Reference books:

1. "Network – On – Chip: From Implementation to programming Paradigm", Sheng Ma Libo Huang Mingche Lai Wei Shi, Margan Kaufman.

COURSE OUTCOMES:

- In depth analysis of Comercial NoCs
- Understanding of basic requirements of NoC topologies and various performance factors.
- Understanding how to avoid deadlocks and lovelocks in various choices of routing algorithms present.
- Understanding the QoS requirements.

E. Cloud Computing

Course Code	MCSE 204E
Course Name	Cloud Computing
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Operating Systems, Virtualization Technologies, Networking.

COURSE OBJECTIVES

- The student will also learn how to apply trust-based security model to real-world security problems**.**
- An overview of the concepts, processes, and best practices needed to successfully secure information within Cloud infrastructures.
- Students will learn the basic Cloud types and delivery models and develop an understanding of the risk and compliance responsibilities and Challenges for each Cloud type and service delivery model.

Syllabus

UNIT I	Hours =40
Introduction to Cloud Computing, The Evolution of Cloud Computing, Hardware Evolution, Internet Software Evolution, Server Virtualization, Web Services Deliver from the Cloud, Communication-as-a-Service, Infrastructure-as-a-Service, Monitoring-as-a-Service, Platform-as-a-Service, Software-as-a-Service, Building Cloud Network	8
UNIT II	
Federation in the Cloud, Presence in the Cloud, Privacy and its Relation to Cloud-Based Information Systems, Security in the Cloud, Common Standards in the Cloud, End-User Access to the Cloud Computing	7
UNIT III	
Introduction, Advancing towards a Utility Model, Evolving IT infrastructure, Evolving Software Applications, Continuum of Utilities, Standards and Working Groups, Standards Bodies and Working Groups, Service Oriented Architecture, Business Process Execution Language, Interoperability Standards for Data Center Management, Utility Computing Technology, Virtualization, Hyper Threading, Blade Servers, Automated Provisioning, Policy Based Automation, Application Management, Evaluating Utility Management Technology, Virtual Test and development Environment, Data Center Challenges and Solutions, Automating the Data Center	10
UNIT IV	
Software Utility Application Architecture, Characteristics of an SaaS, Software Utility Applications, Cost Versus Value, Software Application	7

Services Framework, Common Enablers, Conceptual view to Reality, Business Profits, - Implementing Database Systems for Multitenant Architecture	
UNIT V	
Other Design Considerations - Design of a Web Services Metering Interface – Application Monitoring Implementation - A Design for an Update and Notification Policy - Transforming to Software as a Service - Application Transformation Program - Business Model Scenarios - Virtual Services for Organizations - The Future.	8

Text Books:

1. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice), Tim Mather, ISBN-10: 0596802765,O'Reilly Media, September 2009
2. Bunker and Darren Thomson, "Delivering Utility Computing", 2006, John Wiley & Sons Ltd.

Reference books:

1. John W. Rittinghouse and james F. Ransome, "Cloud Computing Implementation, Management and Security", 2010, CRC Press, Taylor & Francis Group, Boca Raton London New York. [Unit -11 and Unit II]
2. Alfredo Mendoza, "Utility Computing Technologies, Standards, and Strategies", Artech House INC, 2007. [Unit -11I to Unit V]
3. George Reese, "Cloud Application Architectures", O'reilly Publications, 2009.

COURSE OUTCOMES:

After completion of course, students would be able to:

- Identify security aspects of each cloud model
- Develop a risk-management strategy for moving to the Cloud
- Implement a public cloud instance using a public cloud service provider
- Apply trust-based security model to different layer

Elective-IV
A. Formal Methods for System Verifications

Course Code	MCSE 301 A
Course Name	Formal Methods for System Verifications
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	General knowledge in discrete mathematics, and C/C++ programming skill.

COURSE OBJECTIVES:

- Introduce students to the mathematically proving formally specified properties of computer systems.
- Students will be able to learn on theoretical aspects of specification formalisms and algorithm verifications.
- Students should be able to understand mathematically-based techniques for the specification, development, and verification of software and hardware systems.
- Students will acquire skill in using language for model description and specification of model behaviors in modeling and verification of event-driven systems.

Syllabus

UNIT I	Hours = 40
Introduction to the formal methods and modeling systems: *Introduction:* The need for formal methods, Motivation for formal verification, Hardware and software verification, simple verification examples. Modeling systems: Modeling concurrent systems, concurrent systems, Kripke structures, State/configuration of a program or hardware module, Operational semantics and state transition diagrams (finite and infinite-state), Specifying a state transition relation: explicit enumeration and implicit specifications, Constructing a state transition relation from a description of a program or hardware system.	10
UNIT II	
Logical formalism: *Propositional logic:* Declarative sentences, Natural deduction, Propositional logic as a formal language, Semantics of propositional logic, Normal forms, SAT solver. *Predicate logic:* The need of predicate logic, predicate logic as a formal language, Proof theory of predicate logic, Semantics of predicate logic, Undecidability of predicate logic. *Temporal logic:* motivation for their use in specifying properties of reactive systems, The computational Tree logic CTL*, Linear-time Temporal Logic (LTL): syntax, semantics and usage in specifying properties of computer systems, Computation-tree Temporal Logic (CTL): syntax, semantics, difference with respect to LTL and usage in specifying properties, Examples of some commonly specified properties	8

in CTL and LTL.	
UNIT III	
Model checking for verification: *CTL model checking:* CTL model checking using finite Kripke structures: explicit-state algorithms, CTL model checking with fairness, The fixed-point characterization of CTL. *LTL model checking:* LTL model checking using finite Kripke structures: an automate-theoretic technique, Discussion on automate-theoretic LTL model checking, The LTL model-checking algorithm, Reduction of LTL model checking to fair CTL model checking. *CTL* model checking:* The properties of CTL*, LTL and CTL as subset ofCTL*, The expressive power of CTL*. *Study of Verification Tools:* SMV, NuSMV.	8
UNIT IV	
Binary Decision Diagrams, and Symbolic model checking: *Binary Decision Diagrams:* Introduction to Binary Decision Diagram (BDD), and modelling hardware with BDDs , Algorithms for BDD operations, Concept of OBDDs and ROBDDs and operation on ROBDDs. *Symbolic model checking:* Fixpoint Representations, Symbolic model checking for CTL, Fairness of Symbolic model checking, Symbolic LTL model checking.	7
UNIT V	
Model cheeking and Automata Theory: *Introduction: Automata on finite and infinite words, Model checking using automata, Checking emptiness, Translating LTL into automata, On-the-Fly model checking.*	7

Text Books:

1. Logic in Computer Science: Modelling and Reasoning about Systems, 2nd Edition , M. Huth and M. Ryan, published by Cambridge University Press, Copyright © 2011 (Reprinted 2007, 2010, 2011).
2. Model Checking, E. M. Clarke, O. Grumberg and D. Peled, MIT Press, 1999.

Reference books:

1. Higher Order Logic and Hardware Verification, T. F. Melham, published by Cambridge University Press, Print publication year: 1993, Online publication date: January, 2010.
2. Algorithm Design, 1st Edition, Jon Kleinberg, and Eva Tardos, published by Pearson Education Limited, Copyright © 2014. T. F. Melham, Higher Order Logic and Hardware Verification, Cambridge University Press, 1993.
3. The Temporal Logic of Reactive and Concurrent System Specification, Z. Manna and A. Pnueli, Springer-Verlag, 1992.

COURSE OUTCOMES:

- Students will be able to understand formal methods which are applying for Hardware and Software verifications.
- Students will be able to write the formal proofs based on the propositional logic, predicate logic, and temporal logic to verify the hardware circuits and program verifications.
- Students will be capable of writing the formal properties and specifications in computation tree logic (CTL), linear-time temporal logic (LTL).
- Students will be able to verify the systems using CTL and LTL model checking.
- Students will be able to construct and use Binary Decision Diagrams (BDDs) in symbolic model checking.
- Students will be able to understand the model checking using automata and also able to translating LTL into automata.
- Students will be able to learn the verification tools: SMV, PVS.

B. Speech Processing

Course Code	MCSE 301B
Course Name	Speech Processing
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	NIL

COURSE OBJECTIVES:

1. To understand the fundamentals of the speech processing
2. Explore the various speech models
3. Gather knowledge about the phonetics and pronunciation processing
4. Perform wavelet analysis of speech
5. To understand the concepts of speech recognition

Syllabus

UNIT I: INTRODUCTION	Hours =40
Introduction – knowledge in speech and language processing – ambiguity – models and algorithms – language – thought – understanding – regular expression and automata – words & transducers – N grams	8
UNIT II: SPEECH MODELING	
Word classes and part of speech tagging – hidden markov model – computing likelihood: the forward algorithm – training hidden markov model – maximum entropy model – transformation-based tagging – evaluation and error analysis – issues in part of speech tagging – noisy channel model for spelling	8
UNIT III: SPEECH PROCESSING AND SIGNAL PROCESSING	
Phonetics – speech sounds and phonetic transcription – articulatory phonetics – phonological categories and pronunciation variation – acoustic phonetics and signals – phonetic resources – articulatory and gestural phonology	8
UNIT IV: SPEECH IDENTIFICATION	
Speech synthesis – text normalization – phonetic analysis – prosodic analysis – diphone waveform synthesis – unit selection waveform synthesis – evaluation	8
UNIT V: SPEECH RECOGNITION	
Automatic speech recognition – architecture – applying hidden markov model – feature extraction: mfcc vectors – computing acoustic likelihoods – search and decoding – embedded training – multipass decoding: n-best lists and lattices- a* (stack) decoding – context-dependent acoustic models: triphones – discriminative training – speech recognition by humans	8

Text Books:

4. *Daniel Jurafsky and James H. Martin, — Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition, Person education,2013 (https://web.stanford.edu/~jurafsky/slp3/ed3book.pdf)*
5. *Kai-Fu Lee, —Automatic Speech Recognition, The Springer International Series in Engineering and Computer Science, 1999.*

Reference books:

3. *Himanshu Chaurasiya, —Soft Computing Implementation of Automatic Speech Recognition, LAP Lambert Academic Publishing, 2010.*
4. *Claudio Becchetti, Klucio Prina Ricotti, —Speech Recognition: Theory and C++ implementation,Wiley publications 2008.*
5. *Ikrami Eldirawy , Wesam Ashour, —Visual Speech Recognition, Wiley publications , 2011.*

COURSE OUTCOMES:

On Successful completion of the course, Students will be able to

- Create new algorithms with speech processing
- Derive new speech models
- Perform various language phonetic analysis
- Create a new speech identification system
- Generate a new speech recognition system

C. Deep Learning

Course Code	MCSE 301C
Course Name	Deep Learning
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Soft computing/Neural Networks

COURSE OBJECTIVES:

4. To study the basics of neural network and deep learning
5. To study the concepts of gradient descent, Singular Value Decomposition
6. To study various architectures of CNN
7. To understand RNN and its architectures.

Syllabus

UNIT I:	Hours =40
History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Perceptrons, Multilayer Perceptrons (MLPs), Feed Forward Neural Networks, Back propagation Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMS Prop, Adam, Eigen values and eigenvectors Principal Component Analysis and its interpretations, Singular Value Decomposition	8
UNIT II:	
Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders. Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout	8
UNIT III:	
Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization. Learning Vectorial Representations Of Words	8
UNIT IV:	
Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Back propagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks	8
UNIT V:	
Recurrent Neural Networks, Back propagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs Encoder Decoder Models, Attention Mechanism, Attention over images	8

Text Books:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, MIT Press, http://www.deeplearningbook.org
2. “Deep Learning Tutorial”, LISA lab, University of Montreal, 2015 http://deeplearning.net/tutorial/deeplearning.pdf

Reference books:

6. Li Deng and Dong Yu, " Deep Learning: Methods and Applications ", https://www.microsoft.com/en-us/research/wp-content/uploads/2016/02/DeepLearning-NowPublishing-Vol7-SIG-039.pdf.
7. Francois Chollet, "Deep Learning with Python”, Manning Publishing Co, 2018,https://tanthiamhuat.files.wordpress.com/2018/03/deeplearningwithpython.pdf.

COURSE OUTCOMES :

- Students will be able to interact with interdisciplinary course.
- Students will be able to understand the concept of knowledge and knowledge base.
- Students will demonstrate the skills of development of neural net based intelligent system for industrial problems.
- Students will know the design pre-requisites and design procedure of intelligent system.
- Students will understand the concept of pattern classification and pattern association and will try to implement in project work.

D. Internet of Things

Course Code	MCSE 301 D
Course Name	Internet of Things
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Computer Networks

COURSE OBJECTIVES

- Able to understand the application areas of IOT
- Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
- Able to understand building blocks of Internet of Things and characteristics

Syllabus

UNIT I	Hours = 42
Introduction and Applications: smart transportation, smart cities, smart living, smart energy, smart health, and smart learning. Examples of research areas include for instance: Self-Adaptive Systems, Cyber Physical Systems, Systems of Systems, Software Architectures and Connectors, Software Interoperability, Big Data and Big Data Mining, Privacy and Security	8
UNIT II	
IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. **Real-World Design Constraints-** Introduction, Technical Design constraints hardware, Data representation and visualization, Interaction and remote control.	9
UNIT III	
Industrial Automation: Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial **Building Automation**: Introduction, Case study: phase one-commercial building automation today, Case study: phase two-commercial building automation in the future.	9
UNIT IV	
Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases	8
UNIT V	
IOT Physical Devices & Endpoints: What is an IOT Device, Exemplary Device Board, Linux on Raspberry , Interface and Programming & IOT Device, Recent trends in sensor network and IOT architecture, Automation in Industrial aspect of IOT	8

Reference books:

1. Mandler, B., Barja, J., MitreCampista, M.E., Cagáňová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publishing, 2015
2. ArshdeepBahga, Vijay Madisetti "Internet of Things - A Hands-on Approach", Universities Press, First Edition, 2015
3. David Hanes, Gonzalo Salgueiro, and Patrick Grossetete,IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things,CISCO Press, 2017

COURSE OUTCOMES:

- Identify requirements from emerging WSN applications on WSN platforms, communication systems, protocols and middleware
- Understand, compare and evaluate communication and network protocols used in WSNs
- To develop prototypes for domain specific IoTs
- To customize real time data for IoT applications

E. Social Network Analysis

Course Code	MCSE 301 E
Course Name	Social Network Analysis
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Wireless Networks(Desirable)

COURSE OBJECTIVES

- Students will be able to understand and formulate research questions relevant to social network analysis
- Students will understand the sources, advantages, and disadvantages of alternative types of social network data.
- Students will be able to describe a social network and compare attributes across different social networks.
- Students will understand theoretical and empirical issues in current research on social network analysis

Syllabus

UNIT I	Hours=40
INTRODUCTION: Introduction to social network mining. Illustration of various social network mining tasks with real-world examples. Introduction to Semantic Web: Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Social Network analysis: Development of Social Network Analysis – Key concepts and measures in network analysis – Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities – Web-based networks – Applications of Social Network Analysis.	8
UNIT II	
MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION: Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework – Web Ontology Language – Modelling and aggregating social network data: State-of-the-art in network data representation – Ontological representation of social individuals – Ontological representation of social relationships – Aggregating and reasoning with social network data – Advanced representations.	9

UNIT III	
EXTRACTION AND MINING COMMUNITIES IN WEB SOCIAL NETWORKS: Extracting evolution of Web Community from a Series of Web Archive – Detecting communities in social networks – Definition of community – Evaluating communities – Methods for community detection and mining – Applications of community mining algorithms – Tools for detecting communities social network infrastructures and communities – Decentralized online social networks – Multi-Relational characterization of dynamic social network communities.	8
UNIT IV	
PREDICTING HUMAN BEHAVIOUR AND PRIVACY ISSUES: Understanding and predicting human behaviour for social communities – User data management – Inference and Distribution – Enabling new human experiences – Reality mining – Context – Awareness – Privacy in online social networks – Trust in online environment – Trust models based on subjective logic – Trust network analysis – Trust transitivity analysis – Combining trust and reputation – Trust derivation based on trust comparisons – Attack spectrum and countermeasures.	8
UNIT V	
VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS: Graph theory – Centrality – Clustering – Node-Edge Diagrams – Matrix representation – Visualizing online social networks, Visualizing social networks with matrix-based representations – Matrix and Node-Link Diagrams – Hybrid representations – Applications – Cover networks – Community welfare – Collaboration networks – Co-Citation networks.	7

Text Books:

1. Peter Mika, ―Social Networks and the Semantic Web, First Edition, Springer 2007.
2. BorkoFurht, ―Handbook of Social Network Technologies and Applications, 1st Edition, Springer, 2010.

Reference books:

1. GuandongXu ,Yanchun Zhang and Lin Li,-Web Mining and Social Networking – Techniques and applications, First Edition, Springer, 2011.
2. Dion Goh and Schubert Foo,-Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively, IGI Global Snippet, 2008.

COURSE OUTCOMES:

- Understand the basic concepts of social networks
- Understand the fundamental concepts in analyzing the large-scale data that are derived from social networks
- Implement mining algorithms for social networks
- Perform mining on large social networks and illustrate the results

Open Elective Courses

A. Soft Computing Techniques

Course Code	MCSE 303A
Course Name	Soft Computing Techniques
Credits	3L: 0T:-0P (3 credits)
Pre-Requisites	NIL

Course Objectives

- To introduce concept of soft computing techniques and applications.
- To introduce basics of genetic algorithms and their applications in optimization problem
- To introduce the concepts of fuzzy sets, fuzzy logic and its application;
- To familiarize with tools and techniques of Soft Computing;
- To develop skills for solving problems in different application domain using Soft Computing Techniques.

UNIT – I	**Hours=36**
Introduction: Evolution of Computing, Soft Computing Constituents, Hard Computing, From Conventional AI to Computational Intelligence: Machine Learning Basics	**7**
UNIT – II	
Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks	**8**
UNIT – III	
Fuzzy Logic: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.	**8**
UNIT – IV	
Genetic Algorithms and Optimizations: Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning: Machine Learning Approach to Knowledge Acquisition. Single and multi-/many objective optimizations.	**7**
UNIT – V	
Recent Trends in machine learning, various classifiers, neural networks	6

and genetic algorithm.	

Text Books:

3. Neuro-Fuzzy and Soft computing: A Computational Approach to Learning and Machine Intelligence-Jang, Sun, Mizutani, Pearson Education (2004)
4. Principles of Soft Computing – S.N. Sivanandam and S. N. Deepa, Wiley India Pvt Limited (2011)

Reference Books:

4. Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications – S. Rajasekaran and G.A Vijayalakshmipai, Prentice-Hall of India Pvt Limited (2006)
5. Fuzzy Set Theory: Foundations and Applications- George J. Klir, Ute St. Clair, Bo Yuan, Prentice Hall(1997).
6. Neural Networks: Algorithms, Applications and Programming Techniques- Freeman J.A. & D.M.

COURSE OUTCOMES:

- Understanding of the basic areas of Soft Computing including Fuzzy Logic and Genetic Algorithms.
- Apply Genetic Algorithm to solve single objective and multiobjective optimization problems
- Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems

- Apply neural networks to pattern classification and regression problems
- Effectively use existing software tools to solve real problems using a soft computing approach

- Develop some familiarity with current research problems and research methods in Soft Computing Techniques

B. Mobile Technology

Course Code	MCSE 303B
Course Name	Mobile Technology
Credits	3L:0T: 0P (3 Credits)
Pre-Requisites	NIL

COURSE OBJECTIVES

- To study the specifications and functionalities of various protocols/standards of mobile networks
- To learn about the concepts and principles of mobile computing;
- To explore the issues of mobile computing;

Syllabus

UNIT I	Hours = 36
Challenges in mobile computing, Description of cellular system, Frequency Reuse, Propagation Models for Wireless Networks, channel assignment problem , Handoff, types of handoffs; location management	7
UNIT II	
Evolution of Modern Mobile Wireless Communication System - First Generation Wireless Networks, Second Generation (2G) Wireless Cellular Networks, Major 2G standards, GSM: Architecture and Protocols , Overview of CDMA systems: IS-95 Networks	8
UNIT III	
3G Mobile Networks, Cellular –WLAN Integration, Introduction to 4G,WiMAX, LTE	7
UNIT IV	
Mobile IP, Mobile TCP	6
UNIT V	
Introduction to MANET, WSN, VANET and WMN	8

Reference books:

4. P.K. Pattnaik, Rajib Mall, “Fundamentals Of Mobile Computing”, PHI, 2015
5. D.P. Agrawal and Q.A. Zeng, “Introduction to Wireless and Mobile Systems”,3rd edition, Thomson Learning, 2010.
6. J. Schiller, “Mobile Communications”, 2nd edition, Pearson Education, 2012

COURSE OUTCOMES:

- have a good understanding of how the underlying wireless and mobile communication networks work, their technical features, and what kinds of applications they can support
- identify the important issues of mobile computing systems and applications
- have a knowledge about new wireless technologies like VANET, WMN, WiMAX etc

C. Basic Programming Concepts

Course Code	MCSE 303C
Course Name	Basic Programming Concepts
Credits	3L:0T:0P (3 Credits)
Pre-Requisites	NIL

COURSE OBJECTIVES

- The objective of this course is to provide fundamentals of Computer Systems and problem-solving techniques using C language programming.

Syllabus

UNIT I: Introduction	Hours=36
Computer system concepts, characteristics of computer, generations and types of computer, components of computer system, Booting process, classification of digital computer system, organization of computers. Input and Output devices, Storage devices, types of programming languages	7
UNIT II Introduction to Computer Languages	
Evolution of programming languages: first generation, second generation, third generation & fourth generation languages, Language translator: Compiler, Interpreter, Assembler. Operating System - Definition, Job, Objective and evolution of operating system, Types of operating systems.	7
UNIT III: Programming Fundamentals	
Software development life cycle and structured programming, Flowchart and Algorithms, Introduction to C programming, basic programming using input and output operators and expressions, programming using if and if-else, Programming using looping-for, while, do-while; use of switch and break.	7
UNIT IV: Storage Class, Preprocessors, Arrays based Programming and Modular Programming	
Defining and processing 1-d and 2-d arrays for problem solving. Defining and calling a function, modular programming using functions, passing arguments and arrays to functions, functions of void and returning values.	8
UNIT V: Programming using Strings & Structures and Files	
Defining and processing string as array of character, use of null char, defining and processing structures, passing strings and structures to functions. Input and Output Files.	7

Text Books:

6. Yashavant P. Kanetkar, Let Us C, Fifth Edition.
7. E Balaguruswamy, Programming with C, Tata McGraw Hill, 2015.

Reference books:

4. Byron S. Gottfried, Programming with C Language, Schaum Series, Tata McGraw Hill, 2015.
5. Kernighan & Richie, C Programming, Prentice Hall of India, 2002.

COURSE OUTCOMES:

- Learn fundamental knowledge of computer hardware and number systems

- Learn basic terminology used in computer programming
- Develop ability to write, compile and debug programs in C language
- Design programs involving decision structures, loops and functions
- Understand the dynamics of memory by the use of pointers
- Learn the basic concepts of object-oriented programming paradigm

D. Software Engineering Paradigms

Course Code	MCSE 303D
Course Name	Software Engineering Paradigms
Credits	3L:0T:0P (3 Credits)
Pre-Requisites	NIL

COURSE OBJECTIVES

- **To discuss the process for developing large software;**
- **To analyse and model a particular system;**
- **To develop alternative solutions for the system; and**
- **To implement, test and validate a systems design.**

Syllabus

UNIT I	Hours =36
Overview of System Analysis & Design , Business System Concept, System Development Life Cycle, Waterfall Model , Spiral Model, Feasibility Analysis, Technical Feasibility, Cost- Benefit Analysis, COCOMO model, Function Point Analysis(FPA).	8
UNIT II	
System Requirement Specification, System analysis- DFD, Data Dictionary, ER diagram, Process Organization & Interactions. System Design- Problem Partitioning, Top-Down & Bottom-Up design;	7
UNIT III	
Coding & Documentation- Structured Programming, OO Programming, Information Hiding, Reuse, System Documentation.	7
UNIT IV	
Testing- Levels of Testing, White & Black box testing, Integration Testing, structural testing Test case Specification, Reliability Assessment, Validation & Verification Metrics, Monitoring & Control.	7
UNIT V	
Software Project Management- Project Scheduling, Staffing, Software Configuration Management, Quality Assurance, Project Monitoring. CASE TOOLS: Concepts, use and application. Software reliability and quality management.	7

Text Books:

1. *Rajib Mall, Fundamentals of Software Engineering. 3ed, PHI.*

Reference books:

1. R. G. Pressman, Software Engineering, TMH
2. Behforooz, Software Engineering Fundamentals, OUP

COURSE OUTCOMES:

- Discuss the process for developing large software;
- Analyse and model a particular system;
- Develop alternative solutions for the system.
- Implement, test and validate a systems design.

E. Web and Internet Technology

Course Code	MCSE 303E

Course Name	Web and Internet Technology
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	A first module in programming.
Comments	

COURSE OBJECTIVES

1. This course has a practical emphasis on the design and techniques for developing internet-based applications, mainly focusing on web programming.
2. Topics include HTML, client-side scripting language (JavaScript), server-side programming (Servlets, JSP, and J2EE), and XML/web services.
3. This course will also cover some important topics needed for internet-based application developments, such as Internet architectures and web security.

Syllabus

UNIT I	Hours =36
Internet and World Wide Web: Introduction, Internet Addressing, ISP, types of Internet Connections, Introduction to WWW, WEB Browsers, WEB Servers, URLs, HTTP, WEB Applications, Tools for web site creation.	8
UNIT II	
HTML5: Introduction to HTML5, Lists, adding graphics to HTML5 page, creating tables, linking documents, forms, frames, Cascading Style sheets.	7
UNIT III	
Java Script: Introduction, programming constructs: variables, operators and expressions, conditional checking, functions and dialog boxes, JavaScript DOM, creating forms, introduction to Cookies	7
UNIT IV	
AJAX: Introduction, HTTP Request, XML Http Request, AJAX Server Script. **PHP:** Introduction, syntax, statements, operators, PHP and MySQL, PHP	8
UNIT V	
Introduction to ASP.net, J2EE, POJO, Java servlets and JSP.	6

Text Books:

1.Ivan Bayross, Web Enabled Commercial Application Development using HTML, DHTML, JavaScript, Perl CGI, BPB.

2. Steven M. Schafer, HTML, CSS, JavaScript, Perl, Python and PHP, Wiley India Textbooks.

3.Stephen Walhter, Kevin Hoffman, Nate Dudek, ASP.NET Unleashed, Pearson Education.

4.Paul S. Wang, G. Keller, S. Katila, An Introduction to Web Design + Programming, Cengage Learning.

Reference books:

1. *Jeffery C. Jackson, Web Technologies: A Computer Science Perspective, Pearson Education*

COURSE OUTCOMES

After completion of course, students would be able to:

1. Write syntactically correct HTTP messages and describe the semantics of common HTTP methods and header fields
2. Write a valid standards-conformant HTML document involving a variety of element types, including hyperlinks, images, lists, tables, and forms
3. Use CSS to implement a variety of presentation effects in HTML and XML documents, including explicit positioning of elements
4. Demonstrate techniques for improving the accessibility of an HTML document, Javascript, ASP.net.

F. Matlab

Course Code	MCSE 303F
Course Name	Matlab
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	Basic Programming Knowledge
Comments	

COURSE OBJECTIVES

- Understand the Matlab Desktop, Command window and the Graph Window
- Be able to do simple and complex calculation using Matlab
- Be able to carry out numerical computations and analyses
- Understand the mathematical concepts upon which numerical methods rely
- Ensure you can competently use the Matlab programming environment
- Understand the tools that are essential in solving engineering problems

Syllabus

UNIT I	Hours=38
Introduction to Matlab: Matlab Interactive Sessions, Computing with Matlab, Variables, Arrays, Functions and Files	6
UNIT II	
Programming Techniques: Program Design and Development, Relational Operators and Logical Variables, Logical Operators and Functions, Conditional Statements, Loops, The Switch Structure, Debugging Mat Lab Programs	8
UNIT III	
Plotting: XY- plotting functions, Subplots and Overlay plots, Special Plot types, Interactive plotting, Function Discovery, Regression, 3-D plots	8
UNIT IV	
Probability and Statistics: Interpolation, Statistics, Histogram and probability, The Normal Distribution, Random number Generation	8
UNIT V	
Symbolic Processing With Matlab: Symbolic Expressions and Algebra, Algebraic and Transcendental Equations, Calculus, Symbolic Linear Algebra	8

Text Books:

1. *Introduction to Matlab 7 for Engineers, by William J. Palm III, McGraw Hill 2005.*

Reference books:

1. *S. J. Chapman. MATLAB Programming for Engineers. Thomson, 2004*
2. *J. Cooper. A MATLAB Companion for Multivariable Calculus. Academic Press, 2001.*

COURSE OUTCOMES

After completion of course, students would be able to:

- Able to use Matlab for interactive computations.
- Familiar with memory and file management in Matlab.
- Able to generate plots and export this for use in reports and presentations.
- Able to use basic flow controls.

G. Introduction to Cryptography

Course Code	MCSE 303G
Course Name	Introduction to Cryptography
Credits	3L:0T: 0 P (3 Credits)
Pre-Requisites	NIL
Comments	

COURSE OBJECTIVES

Students will try to learn:

- The concepts of classical encryption techniques and concepts of finite fields and number theory.
- And explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms
- And explore the design issues and working principles of various authentication Protocols.
- The ability to use existing cryptographic utilities to build programs for secure communication.
- The concepts of cryptographic utilities and authentication mechanisms to design secure applications

Syllabus

UNIT I	Hours = 36
Introduction and Mathematical Foundations: Overview on Modern Cryptography, Ciphers and Secret Messages, Security Attacks and Services. Number Theory, Probability and Information Theory, Mathematical Tools for Cryptography: Substitutions and Permutations, Modular Arithmetic, Euclid's Algorithm, Finite Fields, Polynomial Arithmetic, Discrete Logarithms. Classical Cryptosystems, Cryptanalysis of Classical Cryptosystems	8
UNIT II	
Conventional and Modern Symmetric Encryption Algorithms: Theory of Block Cipher Design, Feistel Cipher Network Structures, DES and Triple DES, Modes of Operation (ECB, CBC, OFB, CFB)	8
UNIT III	
Modern Symmetric Encryption Algorithms: IDEA, CAST, Blowfish, Rijndael (AES), Key Distribution. Stream Ciphers and Pseudo Random Numbers: Pseudo random sequences, Linear Congruential Generators, Cryptographic Generators, Design of Stream Cipher, One Time Pad	8
UNIT IV	
Public Key Cryptography, Hashes and Message Digests: Prime Numbers and Testing for Primality, Factoring Large Numbers, RSA, Diffie-Hellman, ElGamal, Key Exchange Algorithms, Public-Key Cryptography Standards. Hashes and Message Digests: Message Authentication, MD5, SHA, Modern Trends in Asymmetric Key Cryptography.	8
UNIT V	
Digital Signatures, Certificates, User Authentication: Digital Signature Standard (DSS and DSA), Authentication of Systems: Kerberos, Digital Watermarking and Steganography.	8

Text Books:

1.William Stallings, Cryptography and Network Security, Principles and Practice, 7th Edition, Pearson Education, 2017.

2.Schneier, Bruce, John Wiley & Sons, "Applied cryptography: protocols, algorithms, and source code in C"(20th Anniversary Ed.), 2015.

Reference books:

1.Behrouz A. Ferouzan, "Cryptography & Network Security", Tata McGraw Hill.
2. Mollin, Richard A. "An introduction to cryptography."(2nd Ed.) CRC Press, 2006.

COURSE OUTCOMES

- Identify information security goals, classical encryption techniques and acquire fundamental knowledge on the concepts of finite fields and number theory.
- Understand, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication